Part II. Extended Flight Phase, First Annual Period (July 1, 1966 – July 1, 1967)

I. Introduction

A. Synopsis of Significant Events

The *Pioneer VI* spacecraft was used in making observations of several solar disturbances and a radar bouncing experiment with the planet Mercury during the first annual phase of extended flight. A special series of observations by the spacecraft was made in August 1966, on passes 235, 236, and 237, to learn of any solar activity that might affect a *Lunar Orbiter* launch. The first solar alert of the period was on pass 207 (July 10, 1966). During the last part of May, special coverage was provided for two periods of solar flare activity. Coverage of 27 h was provided for the first period and 12 h for the second. Other solar flare observation passes noted were passes 210 and 428. The radar bouncing experiment with Mercury was performed on pass 557 (June 25, 1967).

B. Significant Changes in Project Requirements

The need for JPL to produce Stanford University predicts ceased with the end of the experiment (July 13, 1966). However, because the *Pioneer* Project Office was using the round-trip flight time information transmitted in conjunction with the Stanford predicts that were no longer produced, JPL was requested to transmit a copy of the nominal predicts for one of the deep space stations to the Project Office on a regular basis.

C. Support Beyond Minimum Commitments

During the first annual period reported here (the first year after DSS 14 officially took tracking responsibility), there were increasing responsibilities for TDS facilities and personnel. Five major launches were supported within a 5-wk interval in the August–September period. *Pioneer VII* was launched August 17. And, in addition to scheduled tracking of *Pioneer VI*, DSS 14 tracked *Mariner IV* on a once-a-month basis, and performed Mercury bistatic experiments in conjunction with Venus station (DSS 13).

D. Overall Performance of Network

That the DSN met its growing responsibilities was acknowledged in a December 19, 1966, message from the *Pioneer* Project Manager, Charles F. Hall, to the personnel at the JPL and the DSN facilities.

"The *Pioneer VI* mission on Day 350, 0731.20 GMT, 1966, has successfully completed an operational life-

time of one year. The scientific data collected over this period has proven to be valuable to the scientific community in initiating an understanding of the solar system and its environment. *Pioneer VI* is continuing its success with regularly scheduled tracking missions utilizing the Mars 210-ft antenna system. Your efforts as part of the *Pioneer* team have played an important role in establishing the above statements as facts. As part of the *Pioneer* family we invite you to join us in celebrating this occasion."

1. Data rate. DSS 14 obtained good data from *Pioneer VI* at a data bit rate of 64 bits/s, providing at least a 9 dB improvement in performance by DSS 14 over other deep space stations. At 64 bits/s and an error rate of one error per 1000 bits, the station extended the range capability for 64 bits/s from 33 million km to 110 million km. The largest portion of gain was attributed to a considerable improvement in system noise temperature (29°K) and other ground system performance elements.

2. Prime tracking function. DSS 14 assumed the prime tracking function of the *Pioneer VI* spacecraft effective with pass 196. The bit rate was 64 bits/s. However, DSS 12 (Echo station at Goldstone) continued to provide the command and telemetry processing, through its ground operational equipment, and recording. Command transmission was provided as needed. During command operations, the DSS 12 antenna receiver/exciter, transmitter, and the tracking data handling subsystem were placed in operation. (The spacecraft was at 8 bits/s duty cycle store during nontracking periods.)

II. Engineering and Operations

A. Tracking Interruption

The most serious problem during the first annual period of activity of the extended flight phase was an antenna mechanical problem that shut down the 210-ft-diam antenna Mars station for a month and a half. Because of a recurring hydrostatic thrust bearing anomaly that caused short tracking interruptions, the station was shut down for major rework by JPL from March 10 to April 28, 1967. Reshimming between the annular ring and the bearing surface finally eliminated mechanical distortion occurring when the pad passed over the bearing surface. (It was possible during this rework effort to put the antenna into normal operation for a 5-h period. This was done to provide maximum capability listening support during the *Surveyor III* terminal sequence and initial operation on the moon.)

1. Bearing improvement. After initial installation of the ground shims, the bearing film height was improved to a minimum of 0.004 in., with 10 areas showing less than 0.005 in. By comparison, on January 27, 1967, there were 21 areas in which film height was 0.003 in. or less. In addition, the overall height variation of the runner was reduced from 0.070 in. measured during construction to 0.015 in., and "dramatic" improvements were made in the flatness in local areas. During May, engineering evaluation and appropriate local area reshimming were continued to improve the minimum film height and to attain a satisfactory bearing pump redundancy operating condition with permanent shims.

2. Other antenna changes. Adjustments were made to reduce the axis cross coupling of the infrared spectrometer (IRS) autocollimation in order to reduce the bias voltage used to offset the fixed alignment error in the cross elevation axis.

During the shutoff period, sensitive level measurements of the thermal stability of the instrument tower indicated the angular movement of the top of the instrument tower was greater than 15 arc seconds. Plans were made to insulate the outside of the wind and thermal shield to reduce the heat transferred into the instrument tower. A new reference groove was cut in the azimuth gear for measuring the runner profile.

The 20-kW transmitter was modified to make the transmitter usable at both the DSN operation frequency band 2110–2120 MHz and the DSN experimental frequency of 2388 MHz. The conversion consisted of replacing the klystron then in use with a klystron with a broader tuning range (2100–2400 MHz). An additional waveguide directional coupler was added to the waveguide systems for power monitoring at 2388 MHz. An automatic switching circuit was used to switch the monitoring circuits to the directional coupler corresponding to the frequency being used. The 20-kW transmitter modification which allowed operation at either 2110–2120 MHz or 2388 MHz increased flexibility, enabling the station to perform special scientific and advanced engineering experiments in addition to the two-way coherent tracking and/or command mission support.

The existing 20-kW waterload was moved to the position allocated for the 100-kW waterload. This move was

required so that the diplexer could be bypassed when the transmitter was operating at 2388 MHz. Waveguide was installed from the waterload position to the 2388-MHz transmitter input port of the special 2110–2120-, 2290–2300-, 2388-MHz feed cone.

B. Anomalies Related to Data Losses

On the whole, DSN support of the *Pioneer VI* mission during the period of this report was considered good. The big exception, the shutdown of DSS 14 from pass 423 to pass 502, has been noted previously. Before and after shutdown, instances of lost data were minor and attributed in part to burn-in or random failure of the relatively new equipment in use. Some of the instances of lost data and equipment anomalies and the steps made for improvement are described in the following paragraphs. More are noted subsequently in tabular material presenting pass chronology.

When the station became operational again (pass 502), occasional low-film indications necessitated braking of the antenna during some passes. In each instance, checking of the actual film thickness revealed a satisfactory condition. As a result of braking, though, some data was lost. The shimming correction was refined. Table 4 shows the signal strength expected for pass 505. The indicated average was −163.8 dBmW. DSS 14 used its diplexer for uplink, but not for downlink. A special cone configuration wherein the uplink is left-hand circular polarization (LHCP), through the diplexer, and the downlink is right-hand circular polarization (RHCP), bypassing the diplexer, was used. This was possible because of the use of an experimental cone and because the spacecraft was linearly polarized. The system noise temperature was lower in this configuration, averaging about 29°K instead of the normal 36°K with the diplexer included. The signal was thus improved by about 0.8 dB.

The transmitter went off because of an interlock failure on the power cabinet during pass 515. As a result, 2.5 h of engineering telemetry data was lost before demodulator lock. This time included the long round-trip light time involved in acquisition. Pass 517 was cut short to provide command capability for DSS 51 with *Pioneer VII*.

On pass 557, DSS 14 was in a receive-only mode because of a transmitter modification. This modification was incorporated to allow radar bouncing at 2388 MHz for performing experiments with the planet Mercury.

Table 4. Abbreviated telecommunication design control (channel 6, pass 505)

No.	Parameter	Value	Tolerance	
1	Total transmitter power, dBmW	+38.4	+0.2	−0.2
2	Transmitting circuit loss, dB	−1.6	+0.5	−0.65
3	Transmitting antenna gain, dB	+11.0	+0.5	−0.5
4	Transmitting antenna pointing loss	Included in (3)		
5	Space loss, dB (2292 MHz, $R = 200 \times 10^{-6}$ km)	−265.6		
6	Polarization loss, 0.7-dB elliptical ratio, dB	−3.0	+0.3	−0.3
7	Receiving antenna gain (210-ft), dB	61	+1.0	−0.5
8	Receiving antenna pointing loss, dB	0		
9	Receiving circuit loss, dB	−0.2	+0.1	−0.1
10	Net circuit loss, dB	−198.4	+2.4	−2.1
11	Total received power, dBmW	−160.0	+2.6	−2.3
12	Receiver noise spectral density (N/B^a), dBmW/Hz (temperature system = 29°K)	−184.1	+0.7	−0.9
13	Carrier modulation loss (0 = 0.9 ± 5%), dB	−4.1 dB	+0.5	−0.5
14	Received carrier power, dBmW	−164.1	+3.1	−2.8
15	Carrier APC noise BW ($2B_{LO}$ = 12 Hz), dB	10.8	+0.0	−0.5

[a]Noise power/bandwidth.

DSS 12 was requested to try to acquire uplink for command purposes, and 2 h was scheduled for this purpose during the end of the pass. However, because of the marginal signal strength at the spacecraft (Table 5) and the limited time available (RTLT was 25 min), satisfactory lock was not obtained.

Although the transmitter was down on passes 551, 559, and 561, no data was lost because the station was able to track in a one-way mode. In contrast to the ground transmitter, the receiver was in both one- and two-way lock case.

C. RF Performance

1. Uplink, downlink signal strengths. Tables 6 through 11 present downlink receiver signal strengths for passes 197 through 561. Figures 5 and 6 present examples of spacecraft uplink receiver signal strength and uplink signal strength vs time, respectively.

Table 5. DSS 12 uplink, pass 557

No.	Parameter	Value	Tolerance	
1	Total transmitter power, dBmW	+70.0	+0.5	−0.0
2	Transmitting circuit loss, dB	−0.4	+0.1	−0.1
3	Transmitting antenna gain, dB	+51.0	+1.0	−0.5
4	Transmitting antenna pointing loss	Included in 3		
5	Space loss, dB (2110.9 MHz; R = 2.294 × 10^8 km)	−266.14	0.0	−0.0
6	Polarization loss, dB	−3.0	+0.5	−0.5
7	Receiving antenna gain, dB	+10.5	+0.5	−0.5
8	Receiving antenna pointing loss	Included in 7		
9	Receiving circuit loss, dB	−1.5	+0.25	−0.25
10	Net circuit loss, dB	−209.54	+2.35	−1.85
11	Total received power, dBmW	−139.54	+2.85	−1.85
12	Receiver noise spectral density (N/B), dBmW/Hz	−164.0	+1.0	−0.5
13	Carrier modulation loss, dB	−3.46	+0.4	−0.4
14	Received carrier power, dBmW	−143.0	+3.25	−2.25
15	Carrier APC noise bandwidth ($2B_{LO}$ = 20 ± 5 Hz), dB	+13.0	+1.25	−1.0
	Carrier performance			
16	Threshold SNR in $2B_{LO}$, dB	6.0		
17	Threshold carrier power, dBmW	−145.0	+2.25	−1.5
18	Performance margin, dB	+2.0	+4.75	−4.5
	Command data performance			
19	Modulation loss (1.25 rad ± 0.5%), dB	−2.83	+0.21	−0.27
20	Received data subcarrier power, dBmW	−142.37	+3.06	−2.12
21	Bit rate (1/T), bits/s	0.0		
22	Required system temperature (N/B), dB	+1.94	+1.2	−1.0
23	Threshold subcarrier power, dBmW	−144.6	+2.25	−1.5
24	Performance margin, dB	+2.23	+4.56	−4.37

Figure 7 indicates measured downlink receiver signal strength vs predicted signal strength, showing where (passes 411 through 416) recalibration occurred after an error was discovered in the RF cabling calibration. Discovery of the error helped to explain the 1- to 2-dBmW-higher signal strength reported by the station as compared with the expected signal strength. The recalibration of the system at DSS 14 was accomplished on

Table 6. Downlink receiving signal strength, passes 197–257

Pass	DSS	Day	Average value, dBmW
197	14	181	−156.8
202	↕	186	−156.3
206	↕	190	−156.7
207	14	191	−156.7
208	14/12	192	−166.4/−156.5
210	↕	194	−166.8
211	↕	195	−156.9
215	↕	199	−156.8
218	↕	202	−157.9
223	↕	207	−157.2
226	↕	211	−157.4
230	14/12	214	−157.3
232[a]	14	216	−158.1
235	↕	219	−158.8
236	↕	220	−157.8
237	↕	221	−157.9
238	↕	222	−158.0
248	14	232	−157.7
250	14/12	234	−157.8
254	14/12	238	−158.4
257	14/12	241	−158.5

[a]Record-only track

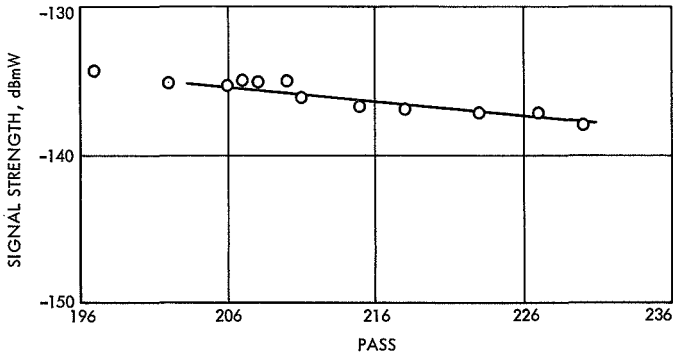

Fig. 5. Uplink receiver signal strength, passes 196–257

February 2, with a 2-dBmW adjustment being made as a result. The actual downlink signal strength on pass 416 therefore reflected that 2-dBmW adjustment. The predicted value, as of pass 416, was within a 1-dBmW

Table 7. Downlink and uplink receiver signal strength, passes 260–320, DSS 14

Pass	Day	Downlink, dBmW	Uplink, dBmW
260	244	−158.0	−128
265	249	−158.4	−127
267	251	−158.6	−127
271	255	−158.3	−127
274	258	−158.5	—
278	262	−158.9	−127
282	266	−158.7	−125
285	269	−158.7	−128
288	272	−159.2	−128
292	276	−159.0	−127
295	279	−158.3	−128
296	280	−158.7	−128
299	283	−158.8	−127
302	286	−158.7	−127
306	290	−159.4	−128
309	293	−158.1	−128
313	297	−158.7	−128
315	299	−158.9	−128
316	300	−158.8	−128
320	304	−159.3	−128

Table 8. Downlink receiver signal strength,[a] passes 322–408

Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW	Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW
322	306	−160.0	−157.8	−172	364	348	−160.9	−156.2	−173
324	308	−160.0	−158.7	−172	366	350	−160.9	−157.4	−172
327	311	−160.1	−158.4	−172	369	353	−161.0	−158.1	−173
329	313	−160.1	−158.2	−173	371	355	−161.0	−158.5	−173
331	315	−160.2	−158.3	−172	372	356	−161.0	−158.3	−173
334	318	−160.2	−158.5	−173	377	361	−161.1	−158.5	−173
336	320	−160.3	−158.0	−173	380	364	−161.2	−158.8	−173
338	322	−160.3	−158.5	172	387	006	−161.3	−158.4	−172
343	327	−160.5	−158.6	−173	390	009	−161.3	−157.6	−172
348	332	−160.5	−157.8	−173	392	010	−161.3	−158.1	−173
350	334	−160.6	−158.4	−173	394	013	−161.3	−157.9	−173
355	339	−160.7	−157.3	−172	404	023	−161.4	−159.4	−171
357	341	−160.7	−158.3	−173	406	025	−161.4	−158.4	−173
359	343	−160.8	−157.8	−173	408	027	−161.5	−158.4	−173

[a]Bandwidth = 12 Hz; maser amplification.

Table 9. Downlink receiver signal strength,[a] passes 411–443

Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW
411	030	−161.6	−158.5	−172
416	035	−161.6	−160.6	−174
418	037	−161.6	−160.6	−175
420	039	−161.7	−161.0	−175
422	041	−161.7	−160.4	−175
425	044	−161.8	−160.7	−175
427	046	−161.8	−161.1	−175
428	047	−161.9	−161.0	
429	048	−161.9	−160.8	−175
432	051	−162.0	−161.2	−175
439	058	−162.0	−161.4	−175
443	062	−162.1	−162.4	−176

[a]Bandwidth = 12 Hz; maser amplification.

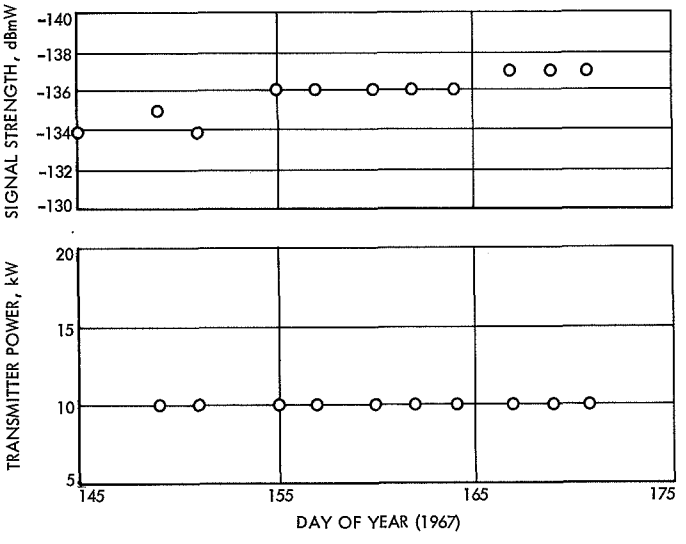

Fig. 6. Uplink signal strength vs time, passes 536–561, DSS 14

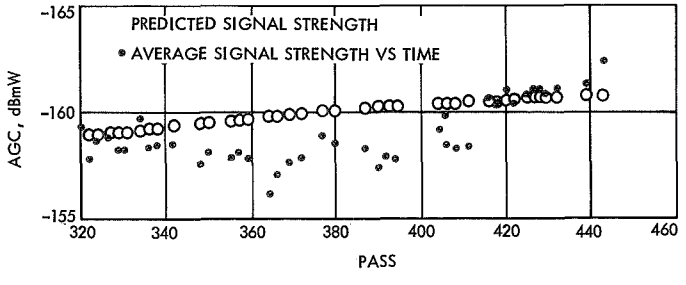

Fig. 7. Downlink measured signal strength vs predicted

tolerance (Table 9). (RF cabling calibration was performed every 6 mo as DSS 14 procedure.)

Data on *Pioneer VI* indicated that DSS 14 was 9 dBmW better than the 85-ft antenna station network. DSS 14 transmitted on one polarization and received on another while tracking *Pioneer VI*. Uplink power for the chan-

Table 10. Downlink receiver signal strength,[a] passes 502–523

Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW
502	121	−162.4	−163.4	−174
505	124	−162.4	−163.8	−175
508	127	−162.5	−164.1	−175
510	129	−162.5	−163.4	−174
515	134	−162.5	−164.4	−175
517	136	−162.5	−164.0	−174
519	138	−162.6	−164.4	−173
522	141	−162.6	−163.9	−175
523	142	−162.6	−164.1	−174

[a]Bandwidth = 12 Hz; maser amplification.

Table 11. Downlink receiver signal strength,[a] passes 536–561, DSS 14

Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW
526	145	−162.6	−164.0	−175
529	148	−162.6	−164.3	−174
532	151	−162.7	−164.7	−174.5
536	155	−162.7	−165.1	−175
538	157	−162.7	−164.8	−174.5
541	160	−162.8	−164.6	−174
543	162	−162.8	−164.7	−174
545	164	−162.8	−164.8	−174
548	167	−162.8	−164.2	−174
550	169	−162.8	−164.5	−173.5
552	171	−162.8	−164.6	−175
555	174	−162.9	−165.0	−174
557	176	−162.9	−165.2	−174
559	178	−163.0	−164.8	−174.5
561	180	−163.1	−164.7	−174.5

[a]Bandwidth = 12 Hz; maser amplification.

nel 7 receiver had a range of −131 to −136 dBmW for 10-kW ground transmitter power from pass 196 through pass 561. The calculated threshold for channel 7 was −147 dBmW, leaving a −11- to −16-dBmW margin before threshold would be reached.

2. Percentage in-lock performance for the DSS. The performances for tracking commitments, transmitter on, and receiver two-way lock status are given in Figs. 8 through 11 and in Table 12. The percentages show the DSS performance during two-way lock with the spacecraft, but do not indicate the amount of data taken. The difference between two-way lock time and tracking time is mainly a result of the long round-trip light time required (20 to 25 min) to lock the receiver in two-way (Fig. 12). However, from pass 555 through pass 561, the

Table 12. Tracking performance: in-lock vs actual and scheduled, passes 536–561

	Time, min	Percentage[a]
Scheduled	7710	100.00
Actual	7763	100.68
Transmitter on	6190	80.28
Receiver in-lock One- and two-way	7185	93.19
Good tracking data	6918	89.72

[a]The indicated percentages are calculated with the scheduled time used as a reference.

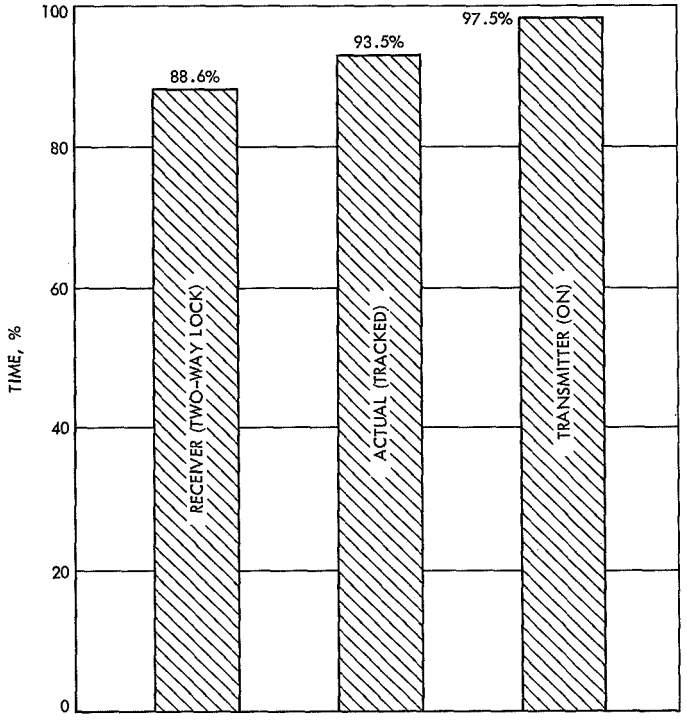

Fig. 8. Tracking performance, passes 322–443

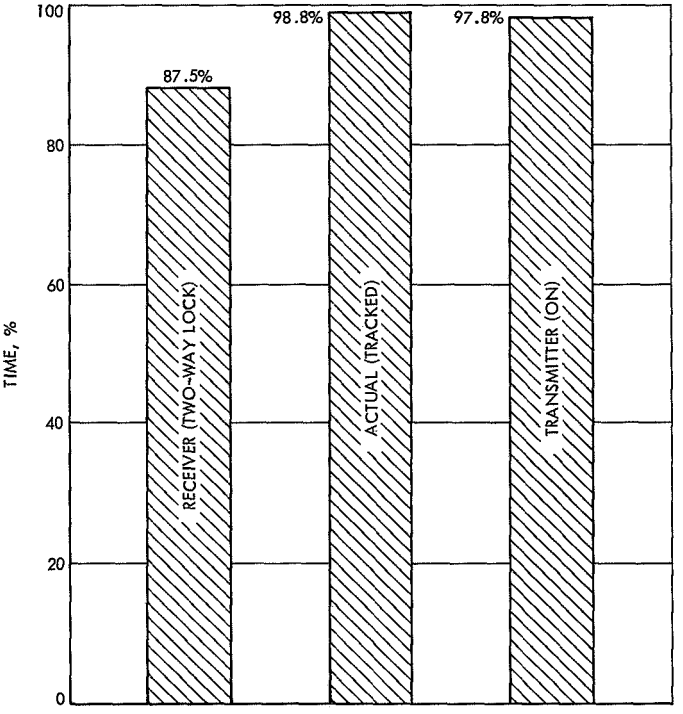

Fig. 9. Tracking performance, passes 502–523

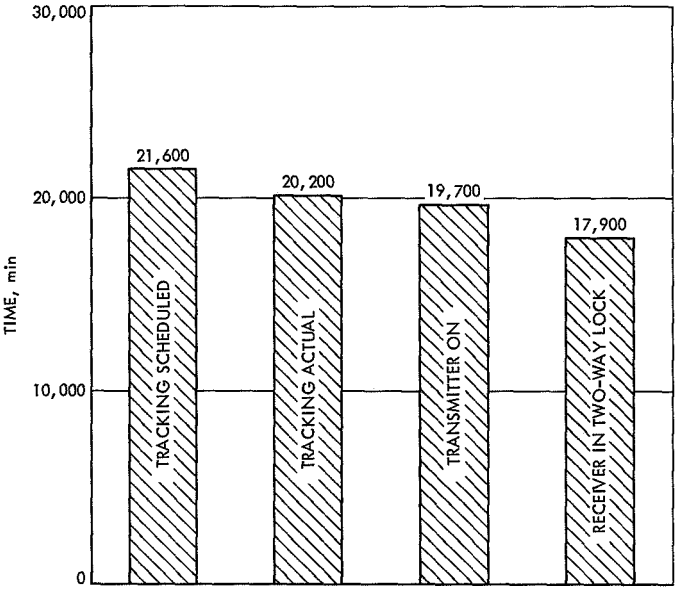

Fig. 10. Tracking performance: in-lock vs actual and scheduled, passes 322–443

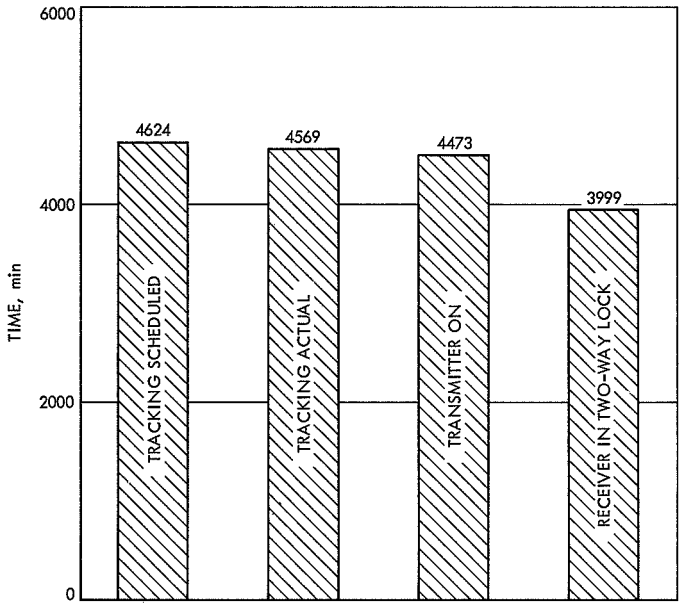

Fig. 11. Tracking performance: in-lock vs actual and scheduled, passes 502–523

DSS 14 transmitter was down for repairs. As a result, the "transmitter-on" percentage was only 80.28 of the scheduled tracking time. The receiver was in both one- and two-way lock case. The one-way data preceding two-way lock was not computed in the percentage. In contrast, from pass 322 through pass 523 the percentage was 97.7. During the transmitter down time (pass 555 through pass 561), no data was lost because the station was able to track in a one-way mode.

D. Parity Error Rate

Figures 13–15 and Tables 13–17 present parity error rate information for the period covered by this document. Generally, DSS 14 performance was free of errors at 16 bits/s. However, the telemetry was not error-free at 16 bits/s during passes 536 through 561. Tables 18 and 19 give system noise temperature data. (A parity error rate of 0.116 was equivalent to one error in 1000 consecutive bits of information and was regarded as the limiting value for the uncoded and convolution-coded unit modes of information.)

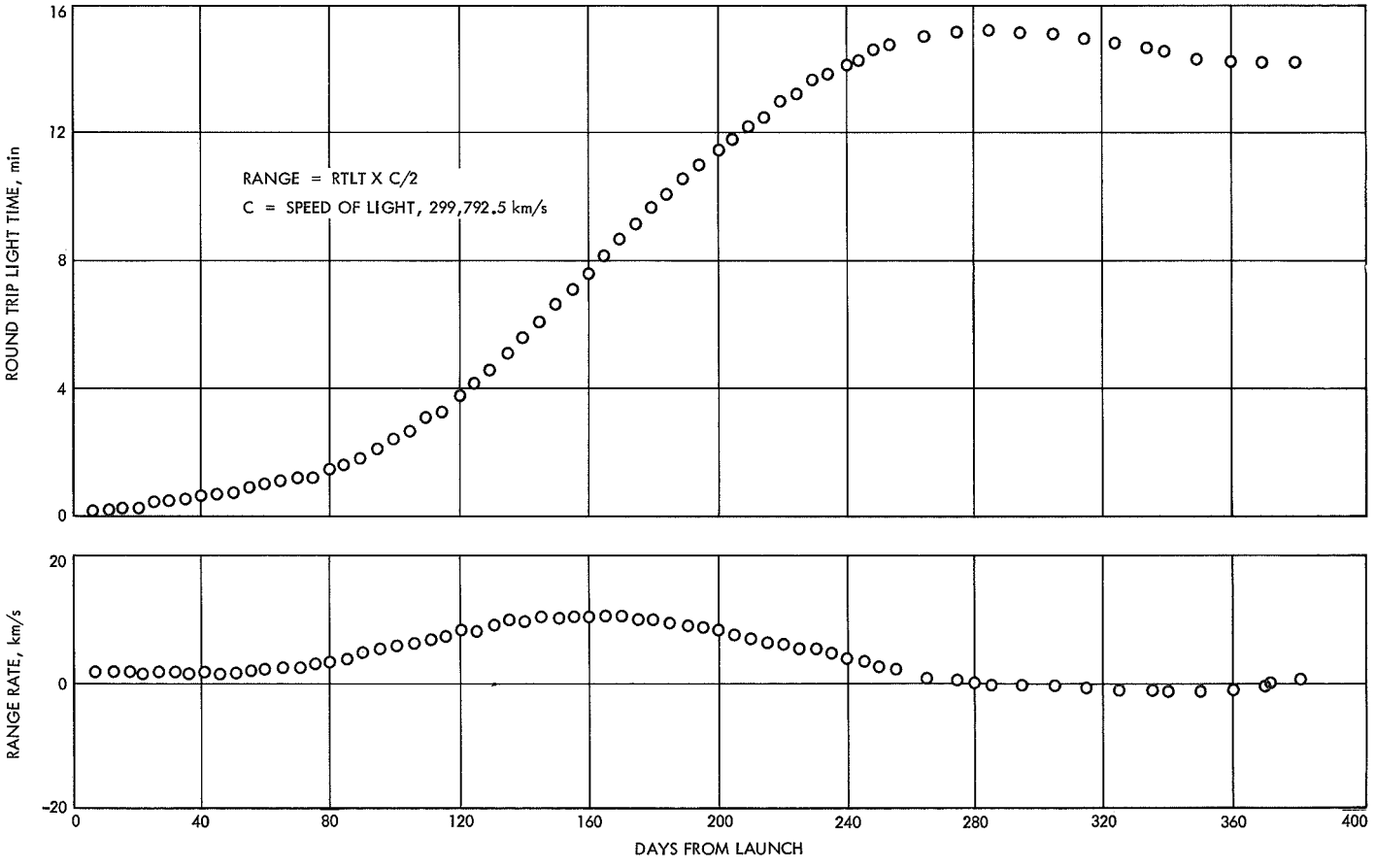

Fig. 12. Round-trip light time vs day of year

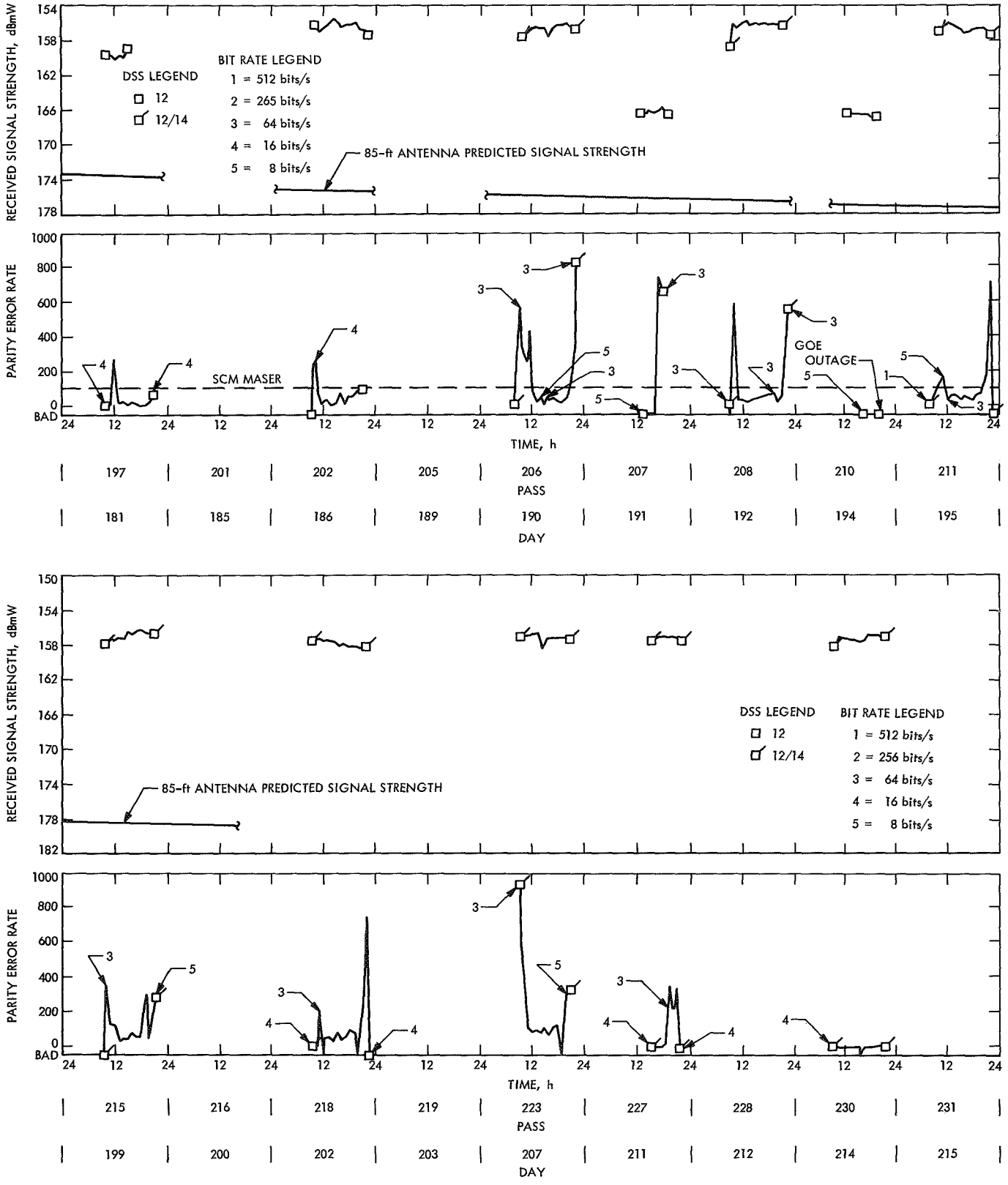

Fig. 13. Received signal strength and parity error rate, passes 197–257

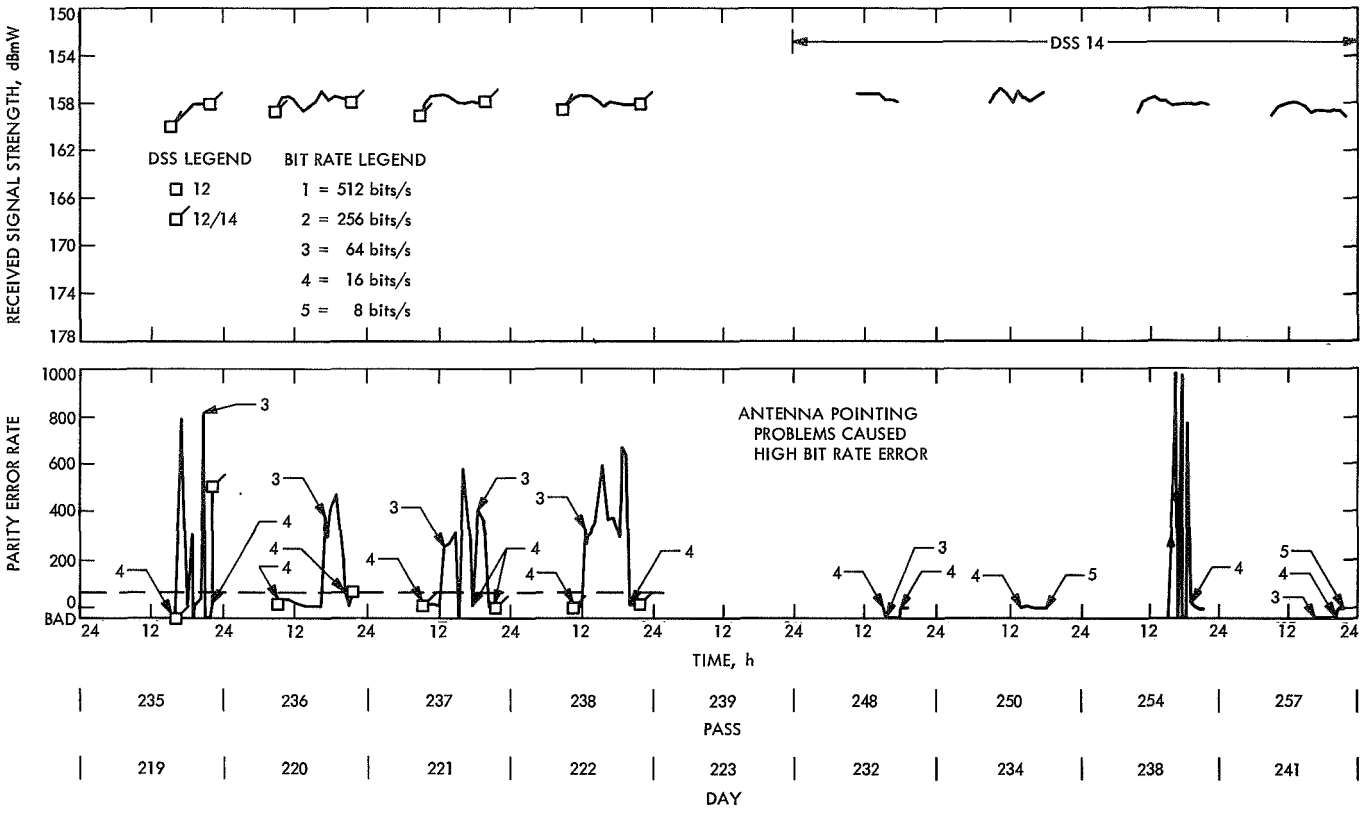

Fig. 13 (contd)

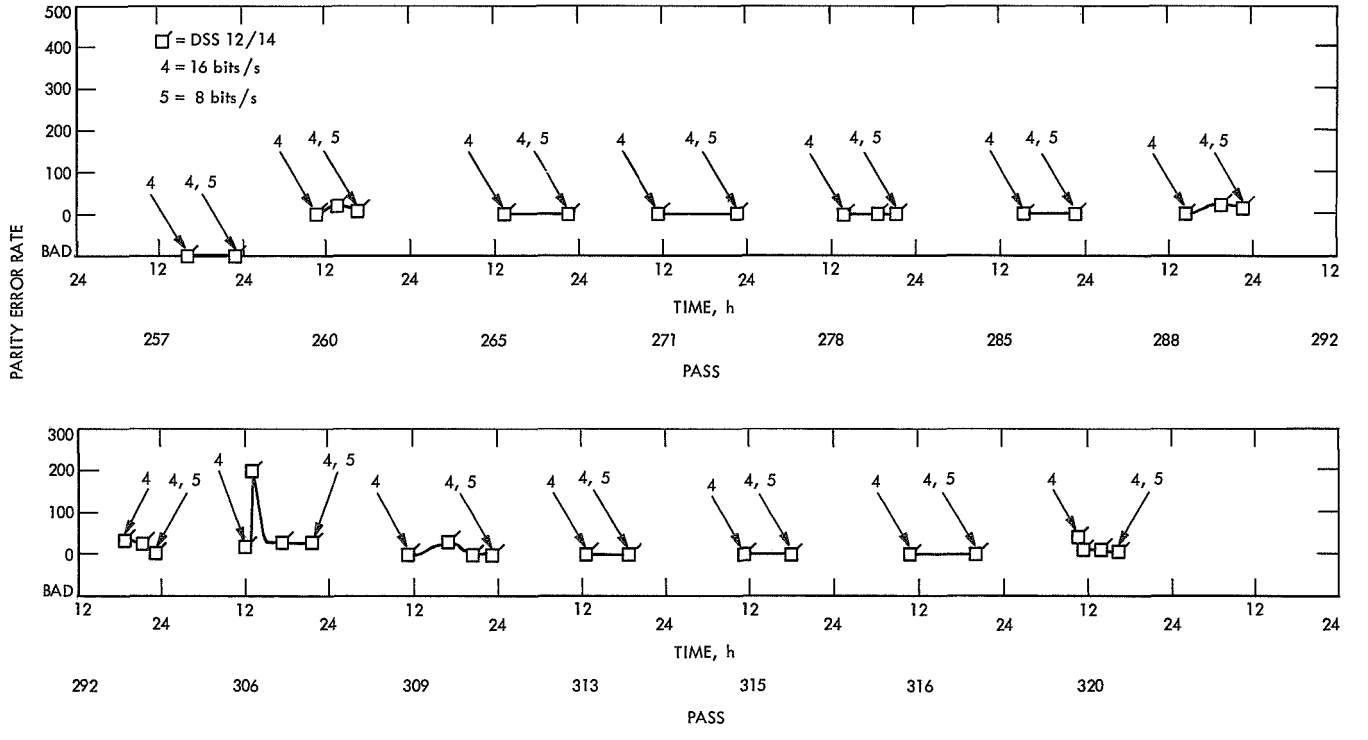

Fig. 14. Received signal strength and parity error rate, passes 257–320

Table 13. Predicted vs actual bit rate change, passes 196–257

Predicted			Actual		
TFL,[a] days	Bit rate, bits/s	Range, km × 10^6	TFL,[a] days	Bit rate, bits/s	Range, km × 10^6
69	512	9.1255085	74	512	11.8
84	256	13.463865	91	256	18.0
114	64	27.0773285	119	64	34.2
130	16	39.0452085	144	16	54.8
176	8	76.295235	164	8	72.8

L + 159 days: parity error rate reached specified maximum of 1×10^{-3} or 0.10%.

L + 166 days: 85-ft antenna data threshold reached. Parity error rate 1×10^{-3} at 8 bits/s.

L + 196 days: DSS 14 (210-ft antenna) began tracking at 64 bits/s with zero bit error rate.

[a]Time from launch on December 16, 1965 (Day 350) at 0731:20 GMT.

Table 14. Parity error rate (bit rate = 16 bits/s), passes 322–416

Pass	Day	Parity error rate (average)	Receiver signal strength (average), dBmW		Pass	Day	Parity error rate (average)	Receiver signal strength (average), dBmW
322	306		−157.8		366	350	0.004	−157.4
324	308	0.001	−158.7		369	353	0.035	−158.1
327	311	0.005	−158.4		371	355	Record only	−168.5
329	313	0.002	−158.2		372	356	0.001	−158.3
331	315	0.006	−158.3		377	361	0.001	−158.5
334	318	0.003	−158.5		380	364	0.004	−158.8
336	320	0.005	−158.0		387	006	0.003	−158.4
338	322	0.000	−158.5		390	009	0.002	−157.6
343	327	0.007	−158.6		392	011	0.001	−158.1
348	332	0.050	−157.8		394	013	0.002	−157.9
350	334	0.000	−158.4		404	023	0.020	−159.4
355	339	0.020	−157.3		406	025	0.001	−158.4
357	341	0.005	−158.3		408	027	0.005	−158.4
359	343	0.006	−157.8		411	030	0.006	−158.5
364	348	0.000	−156.2		416	035	Record only	−160.6

Table 15. Parity error rate (bit rate = 16 bits/s), passes 418–443

Pass	Day	Parity error rate (average)	Receiver signal strength (average), dBmW
418	037	0.002	−160.6
420	039	0.010	−161.0
422	041	0.005	−160.4
425	044	0.000	−160.7
427	046	0.050	−161.1
428	047	0.000	−161.0
429	048	0.002	−160.8
432	051	0.005	−161.2
439	058	0.010	−161.4
443	062	0.050	−162.4

Table 16. Parity error rate, passes 502–523

Pass	Day	Parity error rate (average, computed)	Bit rate, bits/s	Receiver signal strength (average), dBmW
502	121	N/A	16	−163.4
505	124	0.0563	16	−163.8
508	127	0.0603	16	−164.1
510	129	0.0925	16	−163.1
515	134	0.074	16	−164.4
517	136	0.107	16	−164.0
519	138	0.115	16	−164.4
522	141	0.119	16, 8	−163.9
523	142	N/A	16, 8	−164.1

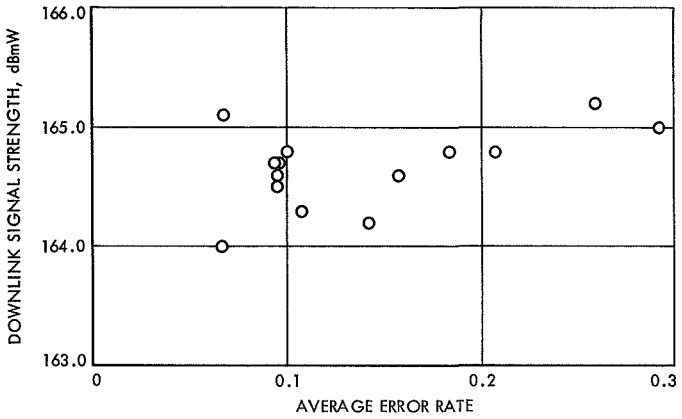

Fig. 15. Parity error rate vs signal strength, passes 536–561, DSS 14

Table 17. Parity error rate (bit rate = 16 bits/s), passes 526–561

Pass	Day	Parity error rate (average)	Receiver signal strength (average), dBmW
526	145	0.0670	−164.0
529	148	0.1123	−164.3
532	151	0.0933	−164.7
536	155	0.0675	−165.1
538	157	0.1006	−164.8
541	160	0.1571	−164.6
543	162	0.0961	−164.7
545	164	0.1788	−164.8
548	167	0.1360	−164.2
550	169	0.0911	−164.5
552	171	0.0961	−164.6
555	174	0.305	−165.0
557	176	0.2635	−165.2
559	178	0.2115	−164.8
561	180	0.2287	−164.7

E. Predicted Frequency Performance

Figure 16 is a plot of the rest frequency measurements from launch for channel 7. Predicted curves for rest frequency were superimposed in order to show the accuracy of the predictions. Figure 17 plots channel 6 rest frequency. Figure 18 is an updated plot of measured auxiliary oscillator frequency. The data compared favorably with the predicted values. Spacecraft receiver and transmitter auxiliary oscillator temperatures are given in Fig. 19. Parameters monitored in non-real-time were as follows.

(1) Station tracking time and mode configuration.

(2) Pre and post signal-to-noise ratio.

(3) Command performance.

(4) On-off events such as the transmitter, receiver, bit rate mode changes, and power level changes.

(5) Demodulator, analog tape recorder, and TCP in-lock percentage.

(6) Two-way RF in- and out-of-lock times in percentages.

Table 18. System noise temperature, °K, DSS 14

Pass	Prepass		Postpass	
	Receiver 1	Receiver 2	Receiver 1	Receiver 2
197	30.3	—	30.8	—
202	29.9	—	32.5	—
206	29.8	—	29.5	—
207	37.6	—	37.9	—
208	28.4	—	29.3	29.6
210	39.6	—	37.4	—
211	30.2	—	—	—
215	27.8	—	29.8	—
218	28.4	—	30.2	—
223	30.0	—	29.1	—
226	29.6	29.1	30	—
230	31.4	30.5	30.4	—
232	—	—	31.5	—
235	31.4	—	31.9	—
236	31.6	31.9	32.9	—
237	—	—	33.0	—
238	—	—	33.0	—
248	—	—	30.8	—
250	—	—	31.0	—
254	—	—	—	—
257	—	—	—	—

(7) Average receiver AGC, average bit error rate, and average uplink power readings.

(8) Tracking data/doppler mode, VCO frequency, and angle performance.

(9) Tracking frequencies, tuning rates, lock times, and drop-lock times for spacecraft acquisition.

Most of these parameters are stored on computer cards for further statistical computation.

F. Predicts and Commands

Predicts generated for *Pioneer VI* to July 1, 1967, are presented in Table 20. A total of 4487 commands had been transmitted by July 1, 1967, the end of this reporting period, with 1219 transmitted during the period. Tables 21 and 22 present a summary of operations.

Table 19. System noise temperature, °K, pre- and postcalibration

Pass	Day	Precalibration	Postcalibration
260	244	32.7	30.2
265	249	30.4	30.3
267	251	28.5	29.3
271	255	28.7	29.6
274	258	—	—
278	262	—	30.9
282	266	—	29.6
285	269	—	—
288	272	—	—
292	276	—	30.0
295	279	29.3	29.4
296	280	29.1	29.0
299	283	28.8	28.7
302	286	30.0	31.2
306	290	30.1	31.2
309	293	29.4	30.0
313	297	29.6	30.1
315	299	30.7	30.1
316	300	30.0	30.5
320	304	29.6	29.2

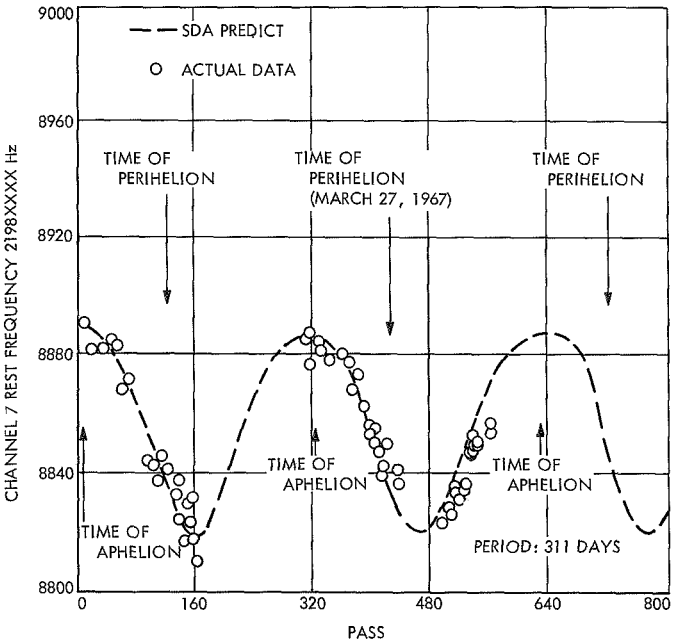

Fig. 16. Channel 7 best-lock rest frequency vs pass number

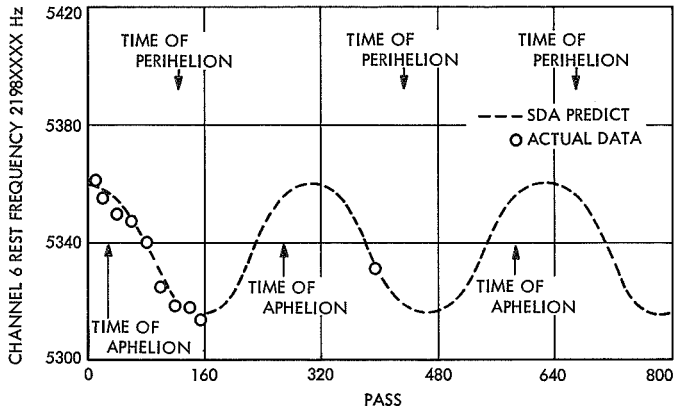

Fig. 17. Channel 6 best-lock rest frequency vs pass number

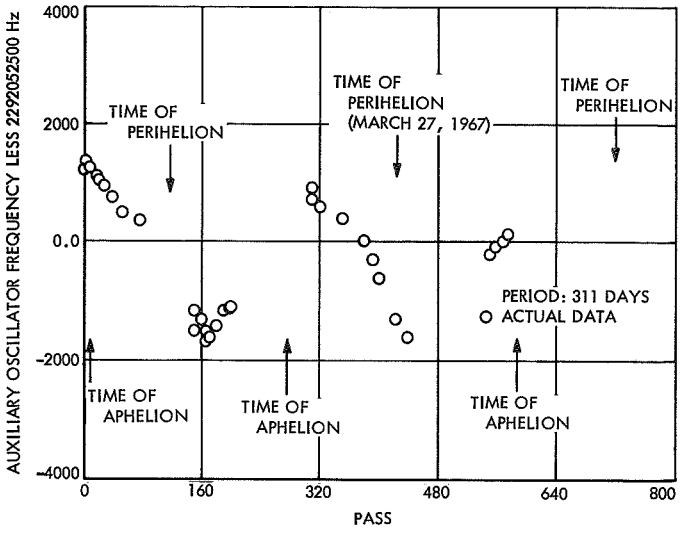

Fig. 18. Auxiliary oscillator frequency vs pass number

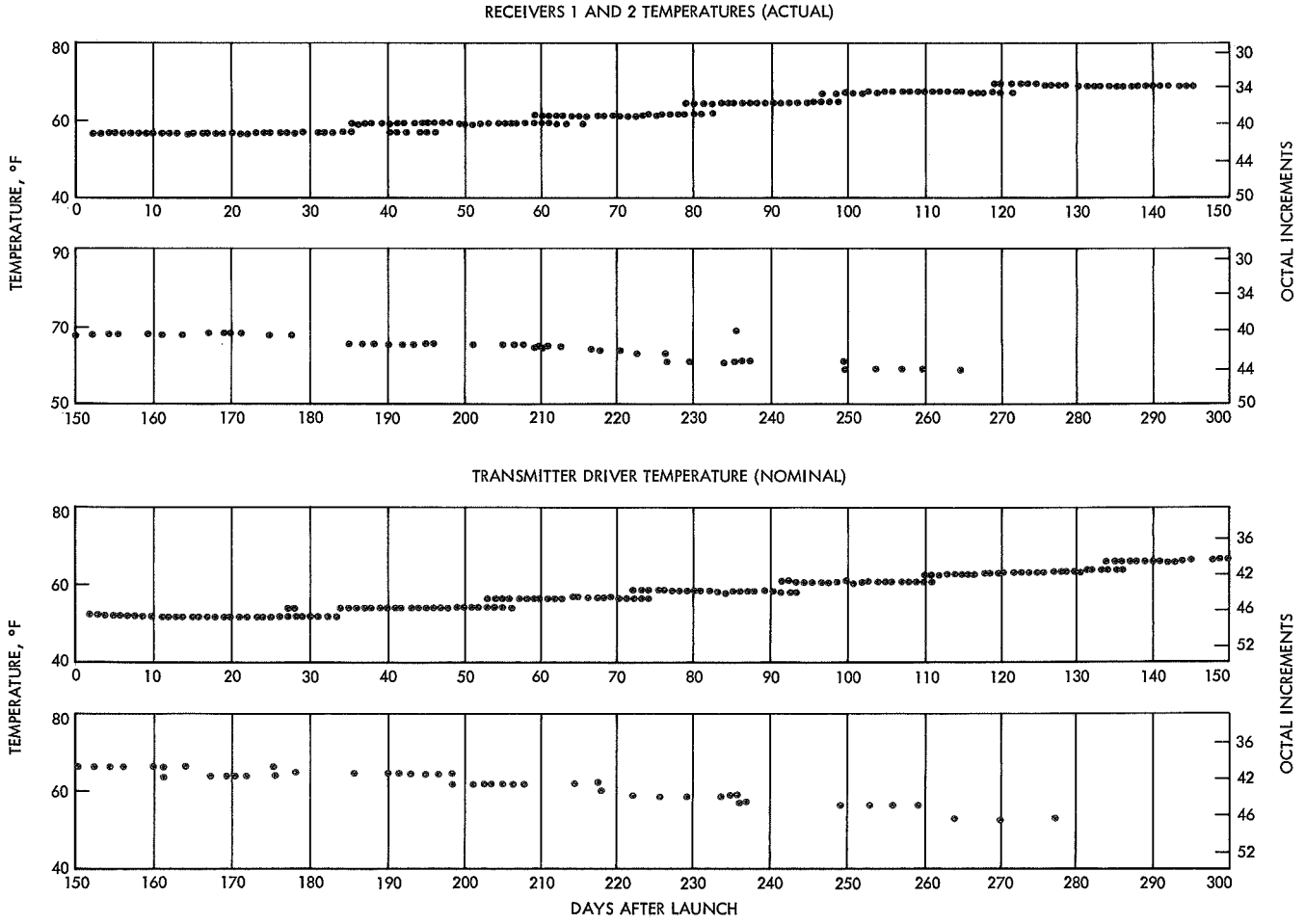

Fig. 19. Spacecraft receiver and transmitter auxiliary oscillator temperatures

Table 20. Prediction summary

Predict No.[a]	Deep Space Stations	Auxiliary oscillator frequency, MHz	Ground transmitter synthesizer frequency, MHz	Coverage	Sample rate, s
61A	14	2292.052500	21.985295	10/23/66–11/24/66	900
61B	14	2292.052500	21.988900	10/23/66–11/11/66	300
61C	14	2292.052500	21.988900	11/10/66–11/24/66	300
62A	14	2292.052500	21.985295	10/23/66–1/1/67	900
62B	14	2292.052500	21.988900	10/23/66–1/1/67	300
63A	14	2292.052500	21.985295	12/30/66–2/2/67	300
63B	14	2292.052500	21.988870	12/30/66–2/2/67	300
63C	12, 14	2292.052500	21.988870	12/20/66–12/22/66	60
63C	12, 14	2292.052500	21.988870	12/22/66–1/2/67	300
63D	12	2292.052500	21.985295	12/20/66–1/2/67	300
64A	14	2292.052500	21.985295	1/31/67–3/2/67	300
64B	14	2292.052500	21.988855	1/31/67–3/2/67	300
65A	14	2292.050500	21.985317	2/28/67–4/1/67	900
65B	14	2292.050500	21.988825	2/28/67–4/1/67	900
66A	14	2292.051400	21.985324	5/1/67–6/1/67	900
66B	14	2292.051400	21.988842	5/1/67–6/1/67	900
67B	14	2292.051950	21.988855	6/1/67–7/1/67	900
67Z*	Stanford	2292.051400	21.985324	6/1/67–7/1/67	300

[a]A = channel 6. B = channel 7. *= made on magnetic tape for 1 mo. C and D = special predict runs for DSS 12 for the last 10 days in December 1966. DSS tracked one pass (noncommittal) at very low signal (−167 dBmW). The tracking data was for correlation with tracking data from the then new 210-ft antenna (DSS 14).

Table 21. Summary of operations, passes 196–257

Pass	Deep Space Station	Number of commands	Average received signal level, dBmW	Transmitter power, kW	Ground modes	Remarks
196	14/12	6	−154.3	10	1- and 2-way	This was the first official tracking pass of *Pioneer VI* by DSS 14. Bit rate, 64 bits/s
197	14/12	10	−156.8	10		Bit rate, 64 bits/s
202	14/12	5	−156.5	10		Bit rate, 64 bits/s
206	14/12	10	−156.7	10		Bit rates, 8 and 64 bits/s
207	12	14	−166.4	10		Pass tracked in support of a solar flare alert. Bit rate, 8 bits/s
208	14/12	7	−156.5	10		TCP computer failed twice, cause undetermined. Bit rate, 64 bits/s
210	12	8	−166.8	10		Pass tracked in support of a solar flare alert. Command 3–100 delayed 6 min due to synthesizer failure. Bit rate, 8 bits/s
211	14/12	5	−156.9	10		Bit rate, 64 bits/s
215	14/12	10	−157.4	10		Bit rates, 8 and 64 bits/s
218	14/12	11	−157.9	10		Bit rate, 64 bits/s
223	14/12	9	−157.3	10		Transmitter interrupted twice due to high body current. Bit rate, 64 bits/s
226	14/12	7	−157.4	10	1- and 2-way	Bit rate, 64 bits/s
230	14/12	2		10	1- and 3-way	Bit rate, 64 bits/s
232	14	None		10	1-way	Bit rate, 64 bits/s. This was a record-only pass.
235	14/12	15		15	1- and 2-way	First pass using the DSS 14 transmitter. This and the three passes following were in support of the *Lunar Orbiter* launch wherein special observations were to be made by *Pioneer VI* of solar activity which might affect *Lunar Orbiter*. Bit rate, 64 bits/s
236	14/12	16		10		Bit rate, 16 bits/s
237	14/12	16		10		Transmitter off briefly due to beam current interlock operation. Bit rates, 16 and 64 bits/s
238	14/12	15		10		Antenna made emergency stop in both axes due to tangling of coolant lines in cable wrap. Transmitter off twice (unscheduled) due to klystron air interlock operation and arc detector interlock operation. Bit rate, 64 bits/s
248	14/12	8		10	1- and 2-way	Station experienced brief primary power failure at 0245 GMT. A problem in transmitting the command microwave tones developed between the multiple mission support area at DSS 12 and the transmitter at DSS 14. It was corrected after several minutes and the cause was unreported. Bit rate, 64 bits/s
250	14/12	10		10	1- and 2-way	Bit rate, 64 bits/s
254	14/12	17		10	1- and 2-way	Transmitter off twice due to arcing in the waveguide. Bit rate, 64 bits/s
257	14/12	20		10	1- and 2-way	Transmitter kicked off four times for brief periods; cause undetermined. 400-Hz power supply interrupted briefly. Bit rates, 16 and 64 bits/s

Table 22. Summary of Operations, Passes 260–561

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT) 1-Way	2-Way	3-Way	Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
260	14	244	090642	1709	090642 093740	093740 170725		-158.5	28	Pass abbreviated due to Mariner IV mission requirements.
265	14	249	091047	222150	091047 094925	095341 222150		-158.8	42	None
267	14	251	090914	2225	090914 093831	093831 222410		-158.5	None	None
271	14	255	090949	221830	090949 094300	094414 221615		-158.4	24	None
274	14	258	091104	180000	091104 095932	100051 180000		-158.6 -158.4	None	Record-only pass. Station was secured early by Operations Control Chief to prepare for Surveyor test.
278	14/12	262	091238	221800	091238 094845	095022 221620		-158.7	20	None
282	14	266	091919	180800	091919 093000	093000 180800		-158.8	None	None
285	14	269	091542	220300	091542 094748	094910 220300		-158.8	21	None
288	14	272	091740	220300	091740 094625	094625 220120		-158.98	11	None
292	14	276	091935	2158	091935 094722 215620 215800	094722 215620		-159.2	12	None
295	14	279	092140	2152	0921 095247 215057 2152	095247 215057		-158.36	10	None
296	14	280	092148	190000	092148 094826	094839 190000		-158.8	None	Record-only pass.
299	14	283	092456	1858	092456 095802	095944 185800		-158.9	11	At 1738 a glitch occurred in the Beta Computer, possibly caused by station personnel working behind Alpha Computer. At 1802 DSS 12 had a major power failure because of storm activity in the area. Power was restored and computer was back in lock at 180315.
302	14	286	093154	1858	093154 100915	100915 1856		-158.8	12	None
306	14/12	290	093726	185614	193726 101414	101414 185614		-159.3	13	At 094300, Tracking Data Handling equipment garbled the voltage-controlled oscillator printout. At 105800, Datex AZ encoder was not operating properly. Encoder was cleaned, and was back in proper operation at 112000. Receiver dropped lock several times between 093726 and 101540.
309	14	293	093450	185800	093450 101700	101700 185630		-158.4	11	Command encoder was switched at DSS 12. At 0935, the telemetry line to DSS 12 failed. Trouble was caused by an intermittent cable at DSS 12 and was repaired at 1039. From 1700 to 1730, the Western Union line to JPL was not working. Trouble developed in the Telemetry and Command Processing System (TCP), causing command zero printouts. Trouble was corrected by changing TCP computer.

Table 22 (contd)

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT) 1-Way	2-Way	3-Way	Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
313	14/12	297	0934	1858	0934 105300	105433 185714		-158.83	11	Station Controller indicated that Predicts 61B appeared to have been generated with wrong station coordinates.
315	14	299	093610	154800	093610 100359	100359 154800		-158.9	7	Station tracked 108 minutes past scheduled time due to error in reading schedule.
316	14/12	300	093650	1858	093650 100319	100319 185620		-158.6	11	Pass scheduled for Day 301 but moved ahead one day due to VIP visitors to Ames Research Center. TCP lost lock due to inadvertent disconnection of telemetry patch to microwave line at DSS 14.
320	14	304	094145	1600	094145 100411	100411 155530		-158.5	11	None
322	14	306	094440	1400	094440 101509	101550 1400		-158.3	12	All doppler data was lost for entire pass due to operator making a bad patch.
324	14	308	094236	183130	094236 1000 103530 105934	110104 183110		-158.6	10	Station was required to shut down at 1830Z, due to Mariner IV commitment. Requirement verbally confirmed by OCC.
327	14	311	0945	181600	0945 1013	1013 181600		-158.4	14	None
329	14	313	094648	1357	094648 101512	101512		-158.3	9	None
331	14	315	094810	1818	094810 102412	102412 181540		-158.8	13	None
334	14	318	113340	2117	113340 120855	121050 211700		-158.68	13	Station experienced difficulty in obtaining spacecraft and, after obtaining it, difficulty in retaining lock. Problem traced to Maser.
336	14	320	095637	1958	095637 102610	102715 195800		-158.3	13	None
338	14	322	095536	211300	095536 102555	103154 211300		-158.3	13	None
343	14	327	095943	195400	095943 101000	111413 195400		-158.5	13	DIS subsystem failed to pull predict tape. Antenna was driven off spacecraft by DIS, which pulled Angle Data early.
350	14	334	100815	1947	100815	123352		-158.2	13	Transmitter turned off several times during pass due to leaking heat exchanger water hose. Water tank was manually filled for remainder of pass, and water hose replaced after completion of pass. At 132834, transmitter turned off due to operator hitting wrong switch while filling water tank.
355	14	339	125442	2050	125442 133042	133147		-157.4	12	Loose connector on waveguide switch caused 2 hour, 40 minute delay in acquisition.
357	14	341	101753	2038	101753 104853	104924 2038		-158.4	13	None
359	14	343	102141	2037	102141 104640	104716		-157.4	13	None
364	14	348	102932	2040	102932 100502	110502 2040		-155.8	13	None
366	14	350	103138	2022	103138 110042	110116 2022		-157.8	14	None

Table 22 (contd)

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT) 1-Way	2-Way	3-Way	Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
369	14	353	103414	2024	103414 110630 111645 114133 114415 121315 133015 135406	110710 111329 114207 114259 121345 132852 135437 2024		-157.6	10	Station had considerable trouble staying 2-way on channel 7 when tuning above 8880 Mc. Slower tuning rate was attempted but did not help. At 135437 station retained acquisition on channel 7 at 8880 Mc, which was 10 cycles below track syn frequency.
371	12	355	103940		103940 115509	120044 203000		-168.4	0	Pass for tracking data only. No commands were sent and no telemetry data were received.
372	14	356	104109	202900	104109 110744	110827 2029		-158.2	11	None
377	14	361	105004	2023	105004 113520	113600 2023		-158.6	13	None
380	14	364	105420	202300	105420 112326	112417 202045		-158.8	13	None
387	14	006	1158	202500	1158 1304 1833 1849	1304 1831 1849 2022		-158.4	12	Power failure occured at station several hours before track time causing Maser to warm up. Inability to start one of the auxiliary power units contributed to Maser warming up. Master equatorial failure due to tripped circuit breaker in HA channel RCVR in lock.
390	14	009	111443	202200	111443 114403	114443 202200		157.6	11	16 bps, TXR 10 kw
392	14	011	111758	1952	111758 114508	120600 195050		-158.0	7	Transmitter power 10 kw, TLM bit rate 16
394	14	013	112112	202200	112112 1320 180530 184400	132033 180255 184457 202112		-158.3	17	TXR at 15 kw, TLM bit rate 16 bps
404	14	023	113815	202200	113815 1205	120609 202100		159.4	13	TXR power at 10 kw. TLM bit rate 16 bps
406	14	025	114200	2023	114200 120925	120959 202055		-158.5	15	Bit rate 16 bps. TXR at 10 kw
408	14	027	114617	2023	114617 121452	121624		-158.5	15	Bit rate 16 bps. TXR at 10 kw
411	14	030	115023	2022	115023 121953	122050 202157		-158.6	15	TXR at 10 kw. TLM at 16 bps
416	14	035	120218	2031	120218 203100			-160.6	0	Record only.
418	14	037	1203	1954	1203 123031	123132 195142		-160.7	16	TLM at 16 bps. TXR at 10 kw
420	14	039	120516	1953	120516 123031	123220 195300		-160.9	15	TLM at 16 bps. TXR at 10 kw

Table 22 (contd)

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT)			Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
					1-Way	2-Way	3-Way			
422	14	041	121100	1954	121100 123650 184415 192502	123720 183438 192614 195115		160.4	13	TXR at 10 kw. TLM at 16 bps
425	14	44	121423	2038	121423 124230	124407 203800		-160.9	14	TXR at 10 kw. TLM at 16 bps
427	14	046	121500	1527	121500 124220	124250 1527		-161.3	8	TXR at 10 kw. TLM at 16 bps and 8 bps
428	14	047	161428	2029	161428 164059	164405 2029		-161.1	7	TXR at 10 kw. TLM at 16 and 8 bps. Solar flare pass.
429	14	048	121645	2038	121645 124238	124405 203715		-160.85	19	TXR at 10 kw. TLM at 16 bps
432	14	051	121942	2023	121942 133244	133750 2022		-161.18	15	TXR at 10 kw. TLM at 16 bps
439	14	058	122403	1856	122403 125647	125832 1855		-161.4	11	TXR at 10 kw. TLM at 16 bps
443	14	062 March 3. 1967	1254	1908	1254 132805	133030 1908		162.3	11	TXR at 10 kw. TLM at 16 bps
502	14	121 May 1, 1967	114644	2130	1146	 1246 2122		-163.46	11	TXR at 10 kw. TLM at 8 bps. Antenna stopped 3 times due to low oil alarm on pad No. 3.
505	14	124	1330		1330 1406	1406 2023		-163.766	14	TXR at 10 kw. TLM at 8 bps
508	14	127	140000		140000 144047	 144221 2056		164.2	12	TXR at 10 kw. TLM at 16 bps
510	14	129	1200	1800	1200 124030	 124525 1854		163.2	12	TXR at 10 kw. TLM at 8 bps
515	14	134	113915	1800Z	113915 122654	 122840 1800		-163.7	11	TXR at 10 kw. TLM at 16 bps
517	14	136	112506	2116Z	112506 121448	 121624 2116		-163.7	14	Pass cut short 1 1/2 hours to provide command capability for 51 PN-7 pass.
519	14	138	112658		112658 121242	 121358		-164.3	12	TXR at 10 kw. TLM at 16 bps
522	14	141	1120	222500	112045 120909	 121655 222500		164.4	14	TXR at 10 kw. TLM at 8 and 16 bps
523	14	142	111815	192500	111815 120236	 120314 192500		164.2	16	TXR at 10 kw. TLM at 16 bps
526	14	145	111532	1817	111532 120703	 120752 1817		164.1	13	TXR at 10 kw. TLM at 8 and 16 bps

Table 22 (contd)

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT) 1-Way	2-Way	3-Way	Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
529	14	148	111258	2300	111250 120700	 120800 2255		164.3	13	TXR at 10 kw. TLM at 8 and 16 bps
532	14	151	112540	1900	1125 1215	 1215 1900		164.7	13	TXR at 10 kw. TLM at 8 and 16 bps
536	14	155	1115	2243	1115 1206	1206 2243		-165.0	18	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
538	14	157	110330	2314	110330 114856	115030		-164.8	13	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
541	14	160	110044	1904	110044 114809	114856 1904		-164.5	13	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
543	14	162	111345	2257	111345 120310	120339		-164.7	17	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
545	14	164	105839	1842	105839 114729	114821		-164.7	15	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
548	14	167	105515	185700	105515 114726	114902 185700		-164.4	14	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
550	14	169	105243	2319	1052 1218	1218 2319		-164.4	17	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
552	14	171	105215	1900	105215 114204	114245 1857		-164.6	14	TLM bit rate at 8 and 16 bps. TXR power at 10 kw. Command 3/016 sent 6 seconds early because of GOE time error.
555	14	174	104952	1600	104952			-165.0	None	TLM bit rate at 16 bps.
557	14/12	176	111335	1846	111335 170329 181145 182523	1718 181101 184125 1846		-165.8	None	Attempted to use DSS 12 for uplink DSS 14 for downlink. DSS 14 unable to hold 2-way lock, signal level varying between -170 dbm and threshold. Station 14 performed RCV search with RCV 2 at channel 6 frequency and was obtaining intermittent lock at that frequency: DSS 12 TXR apparently not able to hold S/C RCV in two-way, causing switching between channel 6 and 7. Dropped S/C PN-6 at 1846 to reconfigure to PN-7.
559	14	178	1051	1605	105100			-164.5	None	TLM bit rate at 16 bps
561	14	180	104545	1604	104545 1604			-164.7	None	TLM bit rate at 16 bps

G. Pass Chronology

Tracking periods covered are identified by the pass number, which is the number of times since launch that the spacecraft was above the horizon of a particular station. Unless otherwise noted, the following entries refer to DSS 14.

Pass 196. A failure in the azimuth A lubricating system was corrected by readjustment of a microswitch. A failed TDH doppler frequency counter was repaired by replacing a loose wire that had been shorting. Because of an operator error, the station tracked in the 4.5-kHz telemetry bandwidth.

Pass 197. An operator inadvertently hit the antenna offset, causing loss of lock for 2 min.

Pass 207. Numerous random receiver glitches[1] occurred at DSS 12 because of low signal level. After transmitter failure at DSS 12, the transmitter was reset; there was no repetition of the failure.

Pass 208. Restarting of the computer program and reseating of loose cards resulted in normal operation for TCP 920 computer programs after a failure. Operation of FR-1400 recorder B modulator tracks returned to normal after a drive belt was replaced. There had been no output during posttrack calibration, and tape speed was 75% off.

Pass 210. The GOE computer buffer power supply was replaced after DSS 12 was unable to obtain TCP

[1]Momentary intermittent anomalies.

lock for first 3 h 32 min of track. DSS 12 also experienced numerous receiver glitches resulting from low signal strength. Replacement of a fuse restored normal operation after a DSS 12 doppler counter was inoperative for 27 min.

Pass 211. A backup computer was employed when the TCP 920 computer failed because of an intermittently operating module. The module was replaced.

Pass 218. Because of a wiring error, the wrong data condition code was printed. The wiring error was corrected.

Pass 223. When DSS 12 transmitter failed twice because of high body current, the focus current was adjusted, returning operation to normal.

Pass 226. Investigation was started when the VCO counter in the TDH and a spare counter failed because of bad circuit boards.

Pass 230. Because of tape recorder stoppage, 1 min 50 s of data was lost before the recorder was restarted.

Pass 232. The TDH doppler counter failed in transmitter 2 mode during prepass calibration; transmitter 1 mode was used for pass.

Pass 235. The station elevation axis encoder hung up three times and caused signal losses during tracking; interim Datex encoding system was the cause.

Pass 235. The station prepared six trouble/failure reports (TFRs) for failure of TDH punch 1 and 2. Transmitter failure resulted from beam voltage overcurrent, body overcurrent, and low water flow. Antenna brake red indicator light was on.

Pass 237. The DSS 14 transmitter went off because of beam current interlock.

Pass 238. The antenna came to emergency stop in both axes because of a coolant line entangled in the cables. The transmitter went off once because of a klystron air interlock, and then again because of the detector.

Pass 248. DSS 14 received no command modulation from DSS 12 GOE for a portion of the pass because of microwave link breakdown.

Pass 254. The station transmitter was off twice because of arcing in the waveguide.

Pass 257. The transmitter was off four times. The servo brake went on because of a blown fuse in the 400-Hz power source. The fuze was replaced and operation returned to normal.

Pass 299. A local storm caused a major power failure at DSS 12; approximately 2 min of GOE computer data was lost.

Pass 309. The telemetry microwave link to DSS 12 was out for 4 min until the faulty cable at DSS 12 was isolated and repaired. The TCP computer B failed at DSS 12, requiring switch to computer; 12 min was lost.

Pass 316. The telemetry patch to the microwave line at DSS 14 was inadvertently pulled, causing the GOE/TCP at DSS 12 to lose lock. The problem was corrected after 2 min 46 s had elapsed.

Pass 322. Because of incorrect frequency bias, some of the doppler data was bad.

Pass 343. While tuning to lock channel 7, the DSS 14 antenna was driven off spacecraft because the DIS did not pull the paper tape.

Pass 350. Because of a heat exchanger problem, the transmitter was off.

Pass 371. The station was on spare synthesizer for a special tracking data requirement.

Pass 416. The antenna was in a brake mode for a special film height test.

Passes 418 through 422. The DSS 14 transmitter was on and off in a series of TCP/GOE and TCP locks.

Passes 425 through 432. The bit rate was switched from 16 to 8 bits/s.

Pass 443. This was the last pass tracked by DSS 14 until pass 502, during which time the station was shut down for major bearing rework.

Pass 502. DSS 14 was again operational on day 121 (May 1, 1967). The transmitter was at 10 kW and the

telemetry at 8 bits/s. The antenna stopped three times because of low oil alarm on pad 3.

Pass 515. The transmitter went off because of power cabinet interlock failure; 2.5 h of telemetry data was lost before demodulator locked.

Pass 517. The pass was cut short to provide command capability for DSS 51 with *Pioneer VII.*

Pass 526. The receiver went out of lock because of a glitch in the master equatorial system.

Pass 536. The receiver went out of lock as a result of the master equatorial hitting the prelimits.

Pass 552. The transmitter subsystem was turned off for 60 s because of a beam voltage overload.

Passes 555, 559, and 561. Tracked without maintaining any uplink (one-way).

Pass 557. The pass was an effort by DSS 12 and DSS 14 to track *Pioneer VI* jointly. DSS 12 provided the uplink but was unable to hold good lock on the spacecraft receiver. DSS 14 maintained the downlink.

Pass 561. The TDH incorrectly listed spacecraft ID as *Pioneer VII.* The ID was corrected to read *Pioneer VI.*

Tables 21 and 22 give a more extensive summary of operations by pass.